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## NOTES ON THE VARIATIONS OF RHEGMATODES.

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During the summer of 1900 I collected about two hundred specimens of *Rhegmatodes tenuis* for the purpose of studying its development. But this I was unable to carry out, owing to the inability of keeping the medusæ long enough in the aquarium to secure the eggs, few seeming to bear ripe gonads at the time of capture.

It was observed that many specimens showed more or less variability, and attention was then directed toward a study of the variations exhibited among the various organs. The comparatively few specimens obtained led to the postponement of a final

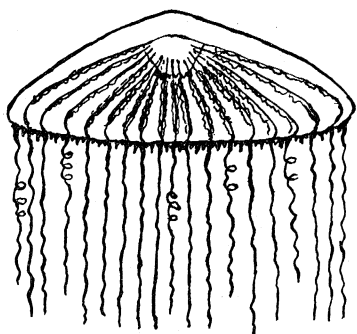


FIG. 1. *Rhegmatodes tenuis*. Semi-diagrammatic.

study of the problem, hoping to secure additional material. This has been carefully sought during three subsequent summers, but in vain; only during 1902 have any specimens at all been found, and these very few and immature. The following "Notes" are therefore submitted as a slight contribution to the general problem of variation among Hydro-medusæ, a more extended ac-

count of which was made by the writer in 1901.<sup>2</sup>

The general features of *Rhegmatodes* are shown in Fig. 1. The medusa varies in size at maturity from about 50 to 95 mm. in diameter. In younger stages the shape is more or less hemispherical, the tentacles and radial canals very much fewer in number, the earliest stage which I have found having but four canals and four tentacles. With growth the number increases very largely, but they are not correlated as at first, the latter becoming more numerous, besides also varying numbers of ten-

<sup>1</sup> Contributions from the Zoölogical Laboratory, Syracuse University.

<sup>2</sup> BIOL. BULL., Vol. II.

tacular spurs or clubs between the bases of the fully developed ones.

In view of the constantly increasing number of these organs, which are the more prominent organs usually involved in variation, it might seem a very uncertain problem to undertake anything like a critical determination of the quantitative variations. So far as the merely numerical aspects of variation are concerned this is undoubtedly true, as will be seen. I may, therefore, say in the outset that, both in view of the doubt just expressed, as well as in the comparatively small number of specimens available, no attempt will be made to present anything like a statistical account. It will be the purpose, rather, to submit a brief account of variations of a qualitative, or substantive character.

So far as I am aware, the only account of variations in the Family *Æquoridæ* is that submitted by Claus,<sup>1</sup> concerning *Æquorea forskalii* in a sharp critique of Haeckel's multiplication of species, and enlargement of the scope of the family. Claus calls attention to the striking differences exhibited by young specimens as compared with adults, and also to the almost equally marked differences as to coloration found in specimens of various ages and sexes, as well as to the highly variable character of the number of canals, shape of mouth and oral arms under different conditions of contraction, etc.

In connection with his description of *Rhegmatores floridana*, Dr. A. Agassiz has merely referred to the fact that in the *Æquoridæ*, "the chymiferous tubes especially are very irregularly formed. They are frequently added all on one side of the spherosome, and almost fully formed before they begin to develop in the other half."<sup>2</sup>

The matters involved in these observations, while both of importance, hardly touch the more fundamental problems of variation as now understood. The critique of Claus is eminently fitting as a protest against the unwarranted multiplicity of species based upon such flimsy characters as those cited. The matters referred to by Agassiz deal more directly with phases of development than with those of variation, though closely related thereto,

<sup>1</sup> Arbeit. Zoolog. Inst., Wien, 1881, p. 283.

<sup>2</sup> "North. Am. Aculephæ," 1865, p. 97.

as will be seen in some of the illustrations of features to be described presently.

In view of the difficulty in accurately studying the otoliths of preserved specimens no attention has been paid to that feature, except incidentally. Something of a similar sort is true concerning the matter of variation in tentacles. They are so subject to mutilation and loss, to inequalities of regeneration, etc., that these also have not been given special attention in connection with this species. Chief attention has been directed to the radial canals, and to a less extent the gonads.

#### ASYMMETRY.

In a few cases marked asymmetry was apparent. In Fig. 2 is shown a condition found in several specimens. In the particular one from which this sketch was made the medusa had 24 radial canals, 12 of which were within a single quadrant of the umbrella, the others being about equally distributed over the other three fourths of the body. As will be observed, several of these canals were incomplete, as were also the associated gonads, the latter appearing to be either rudimentary or tending to degenerate. A somewhat similar condition is shown in Fig. 8; where in addition to the asymmetry, and incompleteness of several of the canals, there is also a fusion of the terminal portions of some of the canals.

The earlier citation of the account of Agassiz concerning the very "irregularly formed" condition of certain of these canals during development is significant in this connection. It would seem as if the condition involved in the case from which this illustration was drawn might be of a similar nature, though in the present instance, it must be remembered, that we are dealing with an adult and not a young specimen. It may not be improbable that in certain instances these apparent irregularities found during development may persist as permanent conditions in the adult

#### RADIAL CANALS.

Attention has been already directed to the fact that the canals increase in number with the growth and age of the medusa. No attention need be taken therefore of this feature in relation to

variation, though when it is remembered that in the vast majority of all Hydromedusæ the radial canals are normally but four in number, the question naturally arises as to the conditions under which this extraordinary increase has arisen, and what it may signify. Such an inquiry would, however, lead too far afield for our present purpose. Mayer has raised and briefly discussed

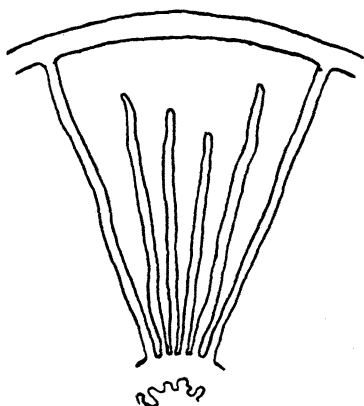


FIG. 2. Showing series of imperfect canals.

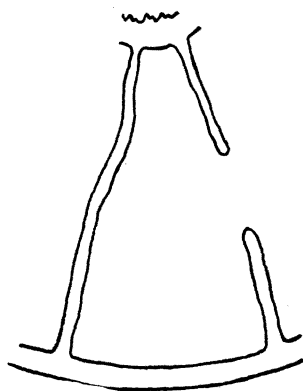


FIG. 3. Showing central and peripheral development of radial canal.

the problem in connection with a study of "The Variations of a Newly Arisen Species of Medusa."<sup>1</sup> In this paper Mayer suggests that one of the ways in which a pentamerous medusa may have arisen from an ordinary tetramerous form is by bifurcation of one of the canals, which, if it became hereditary, would easily account for the condition of pentamerism.

The present writer has discussed somewhat the same general problem in an earlier paper (*op. cit.*, p. 239). If one had only a pentamerous or hexamerous condition for which to find some simple explanation, that just suggested might appear adequate. But when we have conditions like that of *Rhegmatores*, not to mention many others of a similar sort, it will be more or less clear that such an account would be inadequate. It would seem far more probable that these supernumerary canals have arisen under the appropriate stimulus entirely independent of any special phyletic relations.

<sup>1</sup> "Variations in a Newly Arisen Medusa." *Bull. Brooklyn Inst. Arts and Sciences*, Vol. I.

In Figs. 3-5, as well as in those already cited, are shown interesting and more or less common forms of variant canals. Similar conditions are also to be distinguished in several of the other figures given. For convenience we may discuss these features under the following heads: (1) Bifurcations, (2) loops, (3) spurs, (4) anastomoses.

It may be altogether probable that these conditions graduate somewhat insensibly into each other, so that they may really be but varying expressions of one and the same fundamental process. But as suggested, such a classification will at least serve as a convenience in description.

1. *Bifurcations*.—Several illustrations of this feature have already been cited. Others are shown in Figs. 4-6. For the most part these apparently arise as a result of division of the peripherally developing canal, though the centripetally directed type is not lacking, as is seen in Fig. 4. It may be said in passing, that the figures given are for the most part typical ones, each representing usually several similar cases. In development the

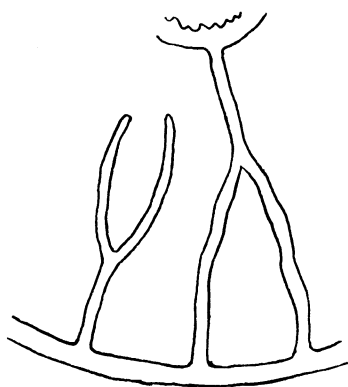


FIG. 4. Showing centripetal and centrifugal canals with bifurcations.

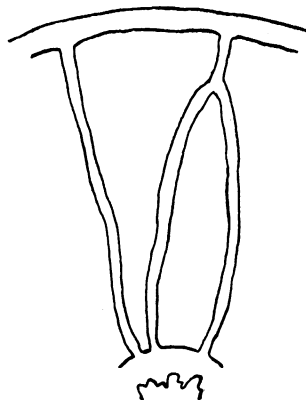


FIG. 5. Showing union of peripheral portions of two canals.

canals usually arise at the gastric pouch and grow toward the periphery. Agassiz (*op. cit.*) has said upon this point, "Additional chymiferous tubes in the *Æquoridæ* are developed from the digestive cavity, as shown by Kolliker, and not from the vertical tube, as in the case of the branching tubes of *Willia*." This I have found to be the case in a study of the very young medusa. On

the other hand, it must not be overlooked that in the Geryonidæ we have for the most part the opposite process, namely, the tubes arising from the marginal canal and developing centrally. Then in Figs. 4, 5 and 6, we have conditions which seem to show undoubtedly that such has been the mode of origin and development in *Rhegmatores*. It brings before us, therefore, a form of variation at once morphological and physiological, or perhaps better, embryological.

2. *Loops*.—In Figs. 7 and 8 are shown what has seemed best described as loops. These seem to have resulted from the fusion of two or more canals whose terminal portions have approximated each other and finally become confluent. These were more or less common conditions among these medusæ. In

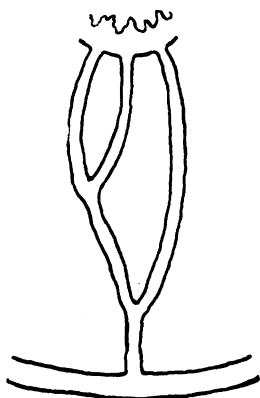


FIG. 6. Showing varying anastomoses.

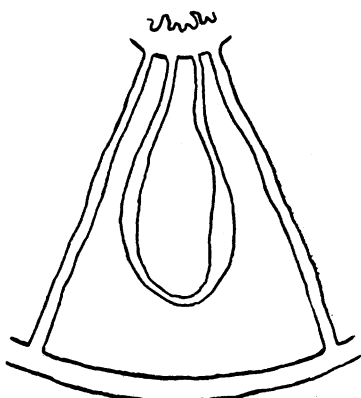


FIG. 7. Showing loop resulting from confluence of distal portions of adjacent canals.

my earlier paper (*op. cit.*) I have figured and described very similar features in *Gonionemus*, and Agassiz and Woodworth have likewise described similar features in the genus *Eucope*.<sup>1</sup> I incline to doubt whether any particular significance may be said to attach to such variations as these. It is certainly hard to discern any particular selective value they might have in the betterment of the species. It seems rather to be illustrative of those types of indefinite or fluctuating variations which abound more or less throughout the organic world, but having little or no bearing or significance in natural selection.

<sup>1</sup> "Variations in the Genus *Eucope*," *Bul. Mus. Comp. Zool.*, Vol. XXX.

3. *Spurs*.—These features are among the most common of the variant phenomena associated with the radial canals. Very few medusæ fail to exhibit something of the sort in greater or less degree. They are, however, more than usually abundant in *Rhegmatores*. In a forthcoming paper on "Variations Among the Scyphomedusæ"<sup>1</sup> I call attention to similar conditions associated with the abundant anastomoses which occur in species of *Aurelia*. As shown in several of the accompanying figures, especially 9 to 12, they probably have some such relation in *Rhegmatores*.

4. *Anastomoses*.—These are features, as just suggested, involving to some extent the preceding, and almost as common, especially in *Rhegmatores*. Figs. 10 to 14 are a few illustrations of a condition found in many specimens, both small and large. Whether a similar condition may be found to occur in other *Æquoridæ* I do not know, or whether similar features exist in other of the Hydromedusæ having supernumerary canals is apparently unknown. When compared with the complex canal system found in the genus *Aurelia* it would at once sug-

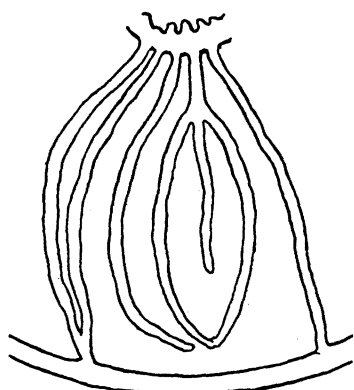


FIG. 8. Showing variously branched and united canals.

gest the query as to whether it might imply any phyletic relation with these medusæ. But this does not seem to me to be the case. It has probably only a more or less indefinite correspondence in the most general way, barely enough likeness to suggest a remote parallelism, but nothing of greater significance. Furthermore, as suggested in the previous section, it is difficult to perceive anything like a definite variation in a given direction,

tending toward the establishment of a type of hydromedusa with a complicated and correlated canal system such as that of *Aurelia*. And while the total of these variational features reached as high as 27 per cent., which is but slightly higher

<sup>1</sup> "Variations Among the Scyphomedusæ," *Jour. Exp. Zool.*, Vol. II.



than the ratio I have found in *Aurelia* (*op. cit.*), it may still be doubted whether it sustains any direct selectional value to the species, any more than in the case of *Aurelia*.

#### GONADS.

The gonads are closely correlated with the radial canals, forming a double fold along the line of each canal. In not a few cases it was found that the gonads of certain canals were more or less rudimentary. Whether this may have been due to arrested development, or to some wholly unrecognized cause it is impossible to say. As a rule, it may be said that in those canals marked by incompleteness, as in Figs. 2, 3 and 4, the gonads were of this character, *i. e.*, showed signs of arrested development, or atrophy. An apparent exception was observed in the case shown in Fig. 7, where in the loops formed the gonads were

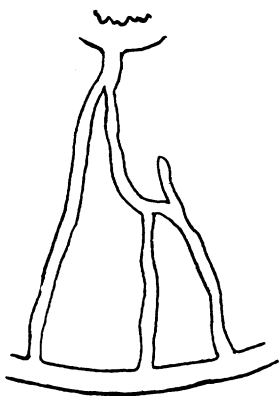


FIG. 9. Showing variations in branching, etc.

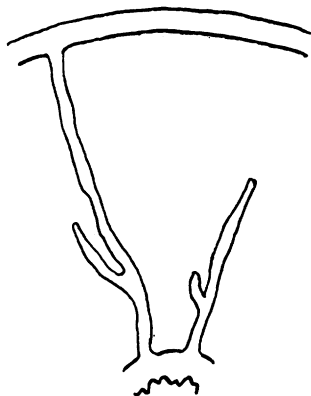


FIG. 10. Showing spurs.

larger and better developed than those of the normal canals of the same specimen. I think an explanation of this condition may be found in the fact that here the short loops of the canals were in closer connection with the gastric pouch, and thus provided with a larger food supply than in either of those of such incompleteness as shown in Figs. 2-4, or indeed the normal canals. Aside from these rather incidental aspects of variation there was little to call for special emphasis, or fuller details.

## TENTACLES.

As intimated in the outstart, there has been given but slight attention to variations in these organs. The tentacles of *Rhegmato-*  
*todes* are both numerous and extremely delicate. It is therefore, difficult to distinguish numerical variations, or irregularity in position. I shall call attention only to one feature, concerning which, however, there is little to be said, the occurrence of branching, or bifurcation. This is a fairly common feature in many medusæ, and in my earlier paper I have figured and described numerous cases. Agassiz and Woodworth (*op. cit.*), have also described several cases among the Eucopidæ. Though somewhat careful attention was directed to this in *Rhegmato-*  
*todes* anything of the sort is extremely rare. Only a single instance

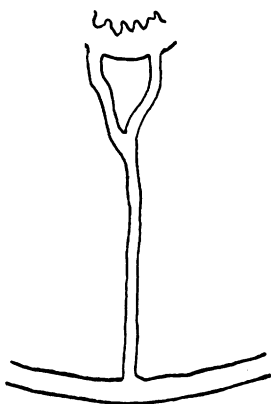


FIG. 11. Showing union of basal canals in a single one.

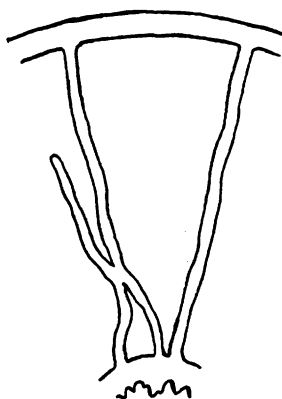


FIG. 12. Showing anastomosis and imperfect canal.

of what seemed to be a basal bifurcation of a tentacle was detected, and that was not so evident as to be absolutely certain.

As a final word upon this feature it may be stated that as a rule the number of tentacles was usually greater as the specimens increase in size. To this, however, there were many exceptions. For example, one specimen measuring 47 mm. in diameter had 66 tentacles, while another which measured but 36 mm. in diameter had 69 tentacles. This may be taken as somewhat typical of many similar cases. In the paper of 1901, already cited, I have called attention to numerous instances of a

similar sort in *Gonionemus*. But as said in another connection, I do not attribute any particular significance to this feature in species like these, in which the numbers are large.

#### OTOCYSTS.

The limited attention directed to these organs gave very much the same results as in the case of tentacles. Ordinarily they are said to occur in a more or less regular order between the bases

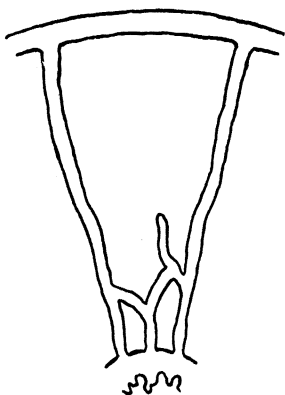


FIG. 13. Showing anastomoses.

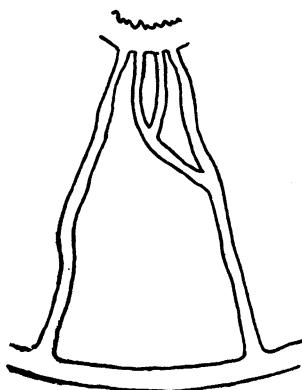


FIG. 14. Showing loops and anastomoses.

of the tentacles ; and in some species this order is very exact, for the most part. But in *Rhegmatodes*, as in *Gonionemus* (*op. cit.*), this does not seem to be the case. While difficult in preserved material to determine in many cases the presence or absence of these minute bodies with exactness, still a careful search in many of the most favorable specimens failed to detect anything like a definite and symmetrical distribution of them. Agassiz (*op. cit.*) has described a single one between the bases of contiguous tentacles. In many cases two were found, and in a few cases even more. But as intimated above, both the difficulty of their determination, and the great liability of loss of tentacles make the matter of a dogmatic statement on this point unwarranted.